Guidance

Central Administration for Pharmaceutical Care

General Administration of Drug Utilization and Pharmacy Practice

National Guidance on Rational Antimicrobial Use Guided by Antibiogram Data

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The Scope of the Guidance

This guidance applies to pharmacists and members of the Antimicrobial Stewardship (AMS) team working in hospital settings for antimicrobial use optimization. It provides a structured framework to support the team for the analysis, interpretation, dissemination, and clinical application of antibiogram data to promote rational antimicrobial prescribing.

Abbreviations

AMR	Antimicrobial resistance
AMS	Antimicrobial stewardship
AST	Antimicrobial Susceptibility Test
C/T	Ceftolozane/tazobactam
CLSI	The Clinical & Laboratory Standards Institute
ED	Emergency department
E.coli	Escherichia coli
FEP	Cefepime
ID	Infectious diseases
IV	Intravenous
I/R	Imipenem/relebactam
ICU	Intensive Care Unit
MEM	Meropenem
MIC	Minimum inhibitory concentration
MRSA	Methicillin-resistant Staphylococcus aureus
MSSA	Methicillin-sensitive Staphylococcus aureus
N	Number
P.aeruginosa	Pseudomonas aeruginosa
% S	Percentage of sensitivity
TZP	Piperacillin/tazobactam
TMP/SMX	Trimethoprim/sulfamethoxazole
WISCA	Weighted incidence syndromic combination antibiogram

Introduction

Antimicrobials are life-saving drugs, and their discovery is among the most important scientific advances of the twentieth century (1). Antimicrobial drugs are losing their efficacy at an alarming rate, fueling a global health crisis known as antimicrobial resistance (AMR) (1). AMR arises when microorganisms evolve mechanisms that enable them to withstand antimicrobial agents that were once effective against them (2). This growing public health emergency compromises the treatment of common infections, resulting in prolonged illness, increased healthcare costs, treatment failures, and a higher risk of severe complications and death (1). Overuse and misuse of antimicrobials are the main drivers for the development of resistance (2). Responding to this crisis, the May 2015 World Health Assembly adopted a global action plan on AMR, which outlines five objectives, one of which is to optimize the use of antimicrobial medicines in human and animal health through antimicrobial stewardship (AMS) (3). A primary principle of AMS programs is to establish effective empirical antibiotic recommendations for commonly encountered infections (3). Suboptimal empirical antibiotics may cause harm to patients, such as delay in effective therapy or treatment failure, and the use of unnecessarily broad-spectrum antibiotics can lead to antimicrobial resistance (4). AMS guidelines advocate for the use of antibiograms (cumulative antimicrobial susceptibility test data) as a tool to guide empirical antibiotic prescribing and inform local treatment guidelines (5).

Definition of Antibiogram

The cumulative (hospital) antibiogram is a periodic profile of antimicrobial susceptibilities of various organisms isolated from patients within an institution, or can be developed to track patterns of resistance in broader geographic areas using data from multiple institutions (6). It is commonly utilized to monitor recent antimicrobial susceptibility patterns to guide empirical antimicrobial therapy selection. A hospital antibiogram gives a clear picture of the most common disease-causing pathogens in various units of the hospital and is considered a core component of antimicrobial stewardship (AMS) (6). An antibiogram provides binary measures of susceptibility (whether a pathogen is non-susceptible or susceptible) but does not provide quantitative data, such as MIC or further categorization of non-susceptibility into intermediate or resistant (7).

Components of the cumulative antibiogram (7)

- Organism names.
- Number of isolates analyzed.
- Antimicrobial agents tested.
- Percentage of each organism interpreted as susceptible to the listed antimicrobial agents based on the CLSI recommended breakpoints. (Table 1)
- Each row represents the organism; each column represents an antibiotic. The Table cell where the column and row meet is the percent susceptible during the period of time that the antibiogram represents. (8)
- Most susceptible antimicrobial for the desired microorganism (represented as a percentage from 0-100%, with 0 indicating no activity and 100 indicating that all isolates are susceptible (9).

Importance of antibiogram

- Set recommendations for optimum empirical treatment. Antibiotic therapy is often started empirically to provide initial control of a presumed infection of unknown cause. Local cumulative antibiograms can inform which empirical antibiotics are most appropriate for patients with common infections (10).
- Develop and support hospital prescribing guidelines (10,11).

- Guide clinicians in the selection of the most appropriate empirical antimicrobial therapy to treat suspected pathogens and avoid the use of ineffective agents when definitive antimicrobial susceptibility test results are not available or delayed (4,11).
- Plan and evaluate AMS interventions to optimize antibiotic use and improve related outcomes (4,11).
- It is one of the points of tracking antibiotic use and outcomes for assessing core elements of hospital antibiotic stewardship programs (12).
- Provide a broad overview of local antibiotic resistance over time (e.g., the proportion of Staphylococcus aureus isolates that are methicillin-resistant) (4,11).
- Compare resistance rates across institutions (4,11).
- Increase awareness of antibiotic resistance (4,11).
- Research has shown that the use of antibiograms can result in reduced reliance on broad-spectrum antibiotics as initial therapy and can result in fewer clinical failures of antibiotics that are first prescribed (13).

Types of Antibiograms

1- **Routine or Single Facility Antibiogram (Traditional)**

- Cumulative (Institutional) Antibiogram: A hospital-wide summary that aggregates data from all clinical isolates over a defined period, typically one year (14). **(Table 1)**
- It is the report generated by analysis of collective Antimicrobial Susceptibility Test (AST) results usually from a single health care facility following CLSI guidance (15).
- It is the most convenient and widely available antibiogram. It is a periodic profile of the proportion of pathogens that are susceptible to an institution's formulary antibiotics over a given time frame, typically 1 year (16).
- Example: Susceptibility of Pseudomonas aeruginosa to piperacillin/tazobactam (TZP) is 90% (16). **(Table 1)**

Table 1. Traditional Antibiogram

A traditional antibiogram evaluates susceptibility for all pathogens collected from all sources.

Report Period:								
Antibiotic Tested	**E. coli**	**Klebsiella pneumoniae**	**Proteus mirabilis**	**Pseudomonas aeruginosa**	**Non-MRSA Staphylococcus aureus**	**MRSA**	**Staphylococcus coag. Negative**	**Non-Vancomycin-resistant Enterococcus species**
N of Isolates‡	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Ampicillin	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
TZP	**0%**	**0%**	**0%**	**90%**	**0%**	**0%**	**0%**	**0%**
	0%	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
	0%	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
	0%	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
	0%	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
	0%	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

*** Light blue bacteria are Gram-negative, and dark blue bacteria are Gram-positive. Light yellow antibiotics are Oral, and dark yellow antibiotics are IV.**

‡ These are pooled isolates by species: Blood, Urine, Sputum, Wound, and Combined specimens. Adopted from the Agency for Healthcare Research and Quality (AHRQ). Toolkit 3. The Antibiogram Program: Antibiogram Development Tool Workbook. (13)

2- **An abbreviated antibiogram**

- It can be constructed from a traditional antibiogram and may be limited to the most common organisms encountered, along with antimicrobials used to treat them (5).

- An abbreviated antibiogram is a practical, user-friendly summary of cumulative antimicrobial susceptibility data that includes only the relevant organisms most commonly encountered and matches the organism to the most effective and safest therapy. This would decrease information overload and provide a simpler version for ease of interpretation (7). (Table 2)

Table 2. Abbreviated Antibiogram

An abbreviated antibiogram evaluates susceptibility for the relevant organisms most commonly encountered in typical infections e.g., *Escherichia coli*, *Klebsiella spp.* and *Pseudomonas aeruginosa*, collected from all sources along with the common antibiotics used for treatment.

Isolates Susceptible, % by agent					
Pathogen (n) / **Antibiotic**	**FEP**	**TZP**	**MEM**	**C/T**	**I/R**
E. coli (40)	**87**	**95**	**99**	**98**	**99**
Klebsiella spp (50)	**91**	**89**	**98**	**95**	**99**
P. aeruginosa (55)	**78**	**90**	**77**	**95**	**93**
n, number of isolates of each pathogen; C/T, ceftolozane/tazobactam; FEP, cefepime; I/R, imipenem/relebactam; MEM, meropenem; TZP, piperacillin/tazobactam.					
Adopted from (7,16)					

3- Enhanced Antibiogram

Enhanced antibiograms, also known as customized or specialty antibiograms (5).

- Enhanced antibiogram assists with more targeted empiric therapy based on infection type, patient type, organism, isolate source, patient location, as follows (15): **(Table 3)**
  - Gram-negative bacilli antibiograms for inpatients, ICU patients, burns patients, outpatients, and patients with cystic fibrosis
  - Urinary tract isolate antibiograms for inpatients, ICU patients, outpatients, patients in an emergency department, and renal transplant patients
  - Blood isolate antibiograms for inpatients, ICU, patients with hematologic/oncologic disorders, and burn patients
  - Streptococcus pneumoniae antibiograms for patients with community-acquired pneumonia or meningitis

- Staphylococcus aureus antibiograms based on patient location (e.g., inpatient, out-patient/ED, ICU patients, etc.)

It is a report where the %S (sensitivity) data are further stratified using:

- Specimen source-specific (Based on infections from specific body sites, such as urinary tract infection, and would only include pathogens reported in urine cultures), it is also called Syndromic or Site-Specific Antibiogram (5,14).
- Patient location: Focused on a particular ward or unit (e.g., intensive care, paediatrics) to capture unique microbial and resistance profiles, it is called a unit-specific antibiogram or location-specific antibiogram (1,14).
- Pathogen-Specific Antibiogram: Concentrates on one bacterial species, providing detailed resistance trends across various antibiotics (14).
- Population-specific (e.g., pediatric or immunocompromised patients) may more accurately describe the risk of infections due to resistant organisms for particular patients (1).
- Multifacility which aggregate data from multiple facilities (15).
- Regional or National Antibiogram: Compiles data from multiple institutions to monitor broader epidemiological trends in antimicrobial resistance (14).

4- **Rolling or Real-Time Antibiogram**

- A rolling antibiogram, also known as a real-time antibiogram, is an antibiogram constructed with a shifting time frame (e.g., last 12 months from today) or a longer time frame according to the context of the facility (5).
- This type of antibiogram provides users with current data while maintaining sufficient isolates to provide statistical validity (minimum of 30 isolates), continuously updates as new culture results are added, and older data drop off as newer data are included (5,16).
- Rolling antibiograms are based on **specific dates** that are input, thus providing the ability to create an antibiogram based on a specific timeframe (7).

5- **Advanced Antibiograms**

Two types of advanced antibiograms, combination and escalation, have recently become more common (5,16):

A combination antibiogram

- It is used to show the likelihood that at least one drug in a combination regimen will cover a given pathogen and provides a useful clinical tool for evaluating antimicrobial coverage (16). **(Table 3)**
- It is more helpful in managing patients at risk of multidrug-resistant organisms (1).
- It can be developed mathematically or through laboratory-based methods; however, the evidence supporting laboratory-based development is currently limited.
- The data are particularly useful when there are significant susceptibility differences in pathogens to individual antibiotics. When interpreting a combination antibiogram, the antibiotic percentage susceptibility should clearly indicate an increase in empirical coverage with the combination compared to the individual agents alone (16).
- Example, Additional susceptibility of Pseudomonas aeruginosa to piperacillin tazobactam (TZP) + gentamicin versus TZP alone. (5,16).
- It is one of the ways recommended by IDSA to identify a more effective strategy to increase the likelihood of optimal empiric therapy for Gram- negative pneumonia in ICUs (18).

Table 3. Combination Antibiogram

A combination antibiogram recovered for gram-negative isolates recovered from a department e.g., medical intensive care unit.

	Isolates Susceptible, % by agent				
	Monotherapy	**Amikacin**	**Gentamicin**	**Levofloxacin**	**Ciprofloxacin**
FEP	**76**	**90**			
MEM					
TZP					
C/T					
I/R					
C/T, ceftolozane/tazobactam; FEP, cefepime; I/R, imipenem/relebactam; MEM, meropenem; TZP, piperacillin/tazobactam.					
Adopted from (18)					

It means the sensitivity of cefepime monotherapy is 76%, while the combination of cefepime and amikacin has a sensitivity is 90% (18).

An escalation antibiogram

- It provides information about susceptibility rates to antibiotics based on their resistance to other agents (5,19).
- Escalation antibiograms can be generated to inform empirical treatment changes in nonresponding patients. These tools can provide important insights, such as discouraging the common practice of escalating therapy from ceftriaxone to piperacillin–tazobactam in cases of suspected Gram-negative bacteremia. As illustrated in Figure 1, Gram-negative isolates resistant to ceftriaxone frequently demonstrate concurrent resistance to piperacillin–tazobactam, thereby limiting the clinical benefit of such escalation (19).

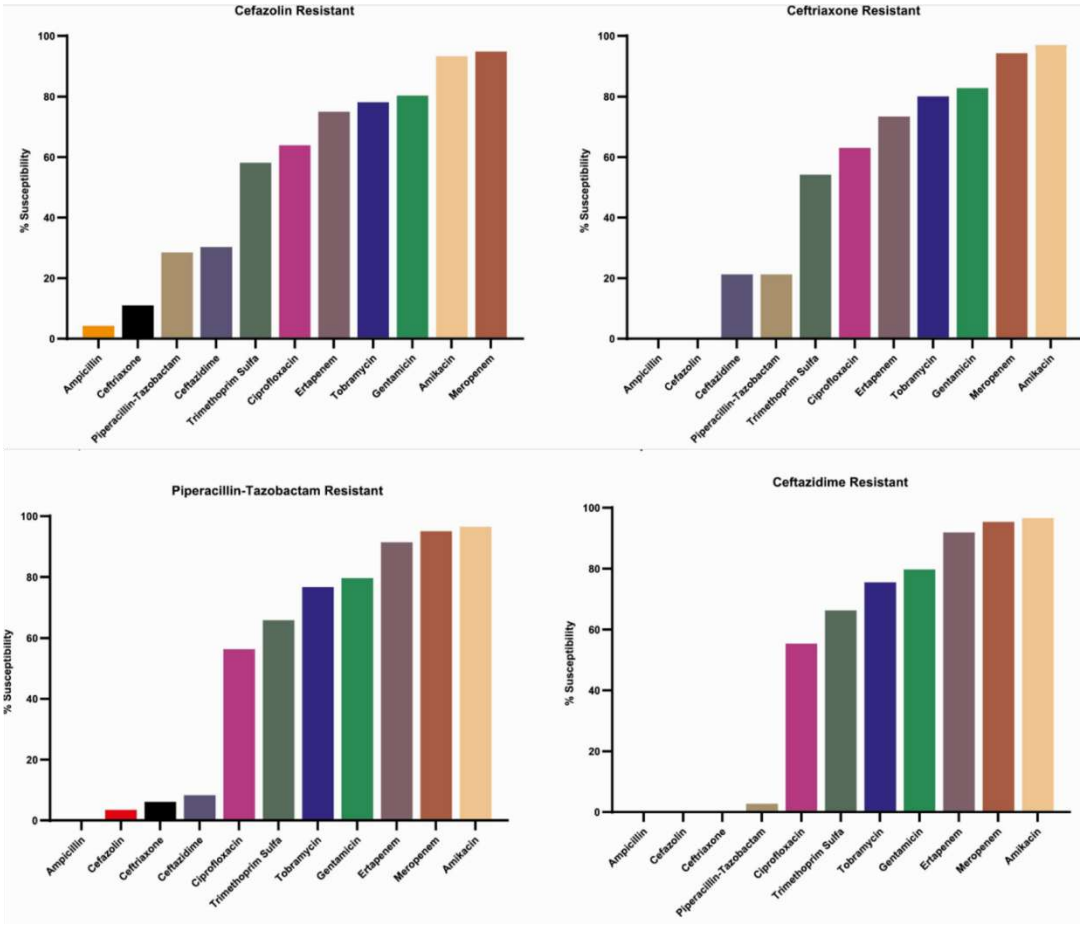

Figure 1. Escalation Antibiogram

Figure 1 introduces the concept of an escalation antibiogram by presenting the susceptibility rates among the subset of Gram-negative organisms resistant to an antibiotic agent of interest, e.g., Piperacillin-Tazobactam and Ceftazidime (19).

Adopted from: Teitelbaum D, Elligsen M, Katz K, Lam PW, Lo J, MacFadden D, et al. Introducing the Escalation Antibiogram: A Simple Tool to Inform Changes in Empirical Antimicrobials in the Nonresponding Patient. Clin Infect Dis. 2022 Nov 15;75(10):1763–1771c

A weighted incidence syndromic combination antibiogram (WISCA)

- WISCA uses electronic healthcare data to provide real-time decision support by integrating patient characteristics (age, gender, and comorbidities) and, subsequently, recommending empirical antibiotic therapy for a specific infectious syndrome (16).
- Example: Pseudomonas aeruginosa susceptibility to TZP among respiratory specimens (obtained among ICU patients only) for male patients aged ⩾65 years with heart failure (16).
- Institutions can create a practical abbreviated antibiogram, in addition to the standard cumulative antibiogram and its variations (7).

Stepwise Approach for Developing Antibiogram-Guided Antimicrobial Stewardship

1- Clinical microbiologists work to present data from lab reports in a way that supports optimal antibiotic use through developing the antibiogram and maintaining it (12, 20).

2- An infectious disease (ID) specialist who is preferred to be a member of the AMS team (or a physician experienced in infectious diseases or a clinical pharmacist) evaluates and interprets the antibiogram (12, 20).

3- ID specialists or a physician experienced in infectious diseases or a clinical pharmacist develop antimicrobial protocols for guiding empiric therapy and antibiotic selection based on susceptibility percentage. The protocols can be used as a general guide to help clinicians with empirical antimicrobial therapy decisions while the results of definitive susceptibility testing are pending or not available (5,20).

4- AMS team disseminates the antimicrobial protocols combined with a copy of the antibiogram to be easily accessible to all stakeholders at a facility by the following forms (5,20): (facility could choose one or more depending on the available resources)

- To be printed and available in a pocket guide format.
- A downloadable file could be distributed via email or placed on the facility's website.
- To be incorporated into a mobile application for use by clinicians at the bedside.

5- ID specialist should do the following functions:

- Develops training programs for the front-line prescribers on the use of antibiograms in treatment selection before the organism is identified (5,20).
- Since the antibiogram can be used when the organism is not yet known, clinicians can look at the most common pathogens isolated at the facility and select therapy based on known causative pathogens for the suspected site of infection. For example, if the patient presents with signs of a urinary tract infection, the clinician could use the antibiogram to identify which pathogens typically associated with that infection are common at the facility (such as Escherichia coli) (5,20).
- Makes decisions about the formulary for antimicrobial agents (ID specialist in collaboration with the other AMS team members).
- Drugs with consistently low activity may be removed or restricted (5,7,20).

Example:

- Klebsiella pneumoniae: (%S Ampicillin 10%, Cefepime 75%)
- The formulary decision in this example is to remove ampicillin for Gram-negative coverage and retain cefepime (7,20).
- Monitors resistance trends (in collaboration with the Infection control physician (or nurse)) (7,20).
- Follows up with lab personnel to update the antibiogram. Updating the antibiogram annually will help maintain its value (20).
- Participates in multifacility, national and regional applications of antibiograms. Some regions or communities may aggregate antimicrobial susceptibility data in a multifacility antibiogram. These can be used to guide prescribing at a facility when local data is not available. They can also be used to identify antimicrobial resistance in a region and serve as a benchmark for individual facilities (5,20).

Evaluation of Antibiogram

Table 4. Evaluation of Local Antibiograms

Points for evaluation	Yes	No	Comments based on the evidence-based medicine
Does the antibiogram have a consistent format that facilitates the analysis and interpretation of data?			This can be accomplished, for example, by organizing results into simple rows and defined columns. (15)
Is a cumulative antibiogram generated annually?			Cumulative antibiograms should be generated at least annually. (15)
Does it contain the following components? • Reporting period • Specimen • Organism names • Number of isolates analyzed • Antimicrobial agents tested • The percentage (%S) for each organism-antimicrobial pairing, which should be interpreted according to the listed antimicrobial agents in the CLSI recommended breakpoints (7,15,21,22).			%S for each organism-antimicrobial pairing is calculated using the following formula (23): %S= $\frac{total\ number\ of\ susceptible\ (s) isolates}{total\ number\ of\ isolates\ tested}\ x\ 100$ Example: Escherichia coli – Ceftriaxone Total E. coli isolates tested against ceftriaxone = 50 Number of susceptible (S) E. coli isolates = 40 % S = (40/50) × 100 = 80 %It means that 80% of E. coli isolates are susceptible to ceftriaxone (23).

Does it include only species with testing data for ≥ 30 isolates?			It should include only species with testing data for ≥ 30 isolates to guarantee statistical validity of the estimates. (21)
If a species with less than 30 isolates, is there a note appended to indicate less statistical validity of the estimates of %S?			A note should be appended to indicate less statistical validity of the estimates of %S (22).
If species with fewer than 30 isolates, is there grouping of several species within a genus together (e.g, Shigella sonnei and Shigella flexneri grouped to be Shigella spp.)?			When there are fewer than 30 isolates, it may be appropriate to group several species within a genus together (e.g., Shigella spp.). This suggestion is for reporting %S data only (22).
If a species with less than 30 isolates, is there combining data on the organism from data collected over more than 12 consecutive months?			If a species with less than 30 isolates, combining data on the organism from data collected over more than 12 consecutive months is appropriate (15).
If a species with less than 30 isolates, is there combining data from several comparable institutions in a geographical area?			Combining data from different types of care institutions (e.g., acute care hospitals plus long-term care facilities) is appropriate (21). Combining data is only appropriate if the %S data among the institutions are similar (21).

<table>
<tr>
<td>Does it include only results from the first isolate of a given species encountered for a patient, and ignore multiple isolates of the same species irrespective of body site, specimen type, antimicrobial susceptibility profile, or other phenotypic characteristics? (15,21,22)</td>
<td></td>
<td></td>
<td>Example: if patient X has the following culture sensitivity results:
<table>
<tr><th>Date</th><th>Specimen</th><th>Organism</th><th>Included in the antibiogram</th></tr>
<tr><td>March 1</td><td>Urine</td><td>Klebsiella pneumoniae</td><td>Yes (the only isolate to be included in the antibiogram)</td></tr>
<tr><td>March 5</td><td>Blood</td><td>Klebsiella pneumoniae</td><td>No</td></tr>
<tr><td>March 30</td><td>Sputum</td><td>Klebsiella pneumoniae</td><td>No</td></tr>
</table>
</td>
</tr>
<tr>
<td>Does it include only diagnostic isolates?</td>
<td></td>
<td></td>
<td>Should not include isolates from screening cultures or from non-patient sources (13).</td>
</tr>
<tr>
<td>Is the calculation at the species level? (15, 21, 22)</td>
<td></td>
<td></td>
<td>Example:
• Escherichia coli (120 isolates)
• Klebsiella pneumoniae (85 isolates)
• Staphylococcus aureus (70 isolates)</td>
</tr>
<tr>
<td>Does it calculate Staphylococcus aureus, and calculate for the subset of methicillin-resistant isolates separately?</td>
<td></td>
<td></td>
<td>MRSA has very different resistance patterns compared to MSSA; separation of MRSA data helps clinicians choose appropriate empiric therapy (15).</td>
</tr>
<tr>
<td>Does it report the percent susceptible (%S) and does not include the percent intermediate in the statistic?</td>
<td></td>
<td></td>
<td>It should calculate the percent susceptible (%S) and does not include the percent intermediate in the statistic (21).</td>
</tr>
<tr>
<td>Does it report results for all drugs that are routinely tested for the species?</td>
<td></td>
<td></td>
<td>It should report results only for antibiotics that are routinely tested. If the laboratory applies selective reporting rules whereby specific antimicrobial agents are tested on merely a subset of isolates, do not report those supplemental results (15).</td>
</tr>
</table>

			It should not report supplemental drugs that are selectively tested on resistant isolates only (21). It is recommended to prepare routine antibiograms using the results of all antimicrobials routinely tested that represent therapeutic alternatives for the species, even if they are not routinely reported to clinicians (22).

Developing antimicrobial protocols for guiding empiric therapy and antibiotic selection based on the antibiogram

1- Recommendations on the empirical antimicrobial therapy are preferred to be specified separately for outpatient treatment, inpatient treatment, non-ICU treatment, and inpatient ICU treatment, considering clinical condition and presence of co-morbidities (24).

6- If the antibiogram revealed that the prevalence of P. aeruginosa is less than 5%, there is no need for empiric therapy with P. aeruginosa coverage (25). (Figure 2)

7- If the antibiogram revealed that the prevalence of MRSA is less than 10% of S. aureus isolates, there is no need for empiric therapy covering MRSA (26).

8- If the risk of morbidity and/or mortality is high, agents with 90-95% susceptibility should be selected as empiric therapy. Agents with 80-85% susceptibility may be accepTable for treating infections in patients without a risk for morbidity and/or mortality in the next 24-48 hours (5).

(A general rule is that if the resistance rate is above 20% (i.e. susceptibility<80%), then that drug should be avoided as empiric therapy for serious infections. For critically ill patients, that threshold may become even stricter (> 5 or 10%) (27).

9- If significant resistance (<80 %^ sensitive), there might be a need for the use of a combination of 2 antibiotics (5,28).

10- The antibiotic regimen should be recommended by international/national guidelines.

11- Pharmacotherapeutic factors such as site of infection, antimicrobial pharmacokinetic/pharmacodynamic properties, for example:

- Moxifloxacin attains lower urinary levels than other fluoroquinolones and is not preferred to be used in UTI treatment. (7,29).
- Daptomycin is not effective for treating pneumonia (especially community-acquired or bronchial-alveolar pneumonia) even when the pathogen tests susceptible (30).
- Aminoglycosides (e.g., gentamicin, tobramycin) may show good in vitro susceptibility against Gram-negative organisms on an antibiogram, but they have poor penetration into lung tissue and the central nervous system when used systemically. This limits their effectiveness in pneumonia and meningitis, despite “susceptible” reporting (31).

- Aminoglycosides are not preferred in treating abscesses or other infections associated with anaerobic conditions.

12- Complicated or uncomplicated infection, e.g., Nitrofurantoin is used for the uncomplicated cystitis, not complicated UTI. As nitrofurantoin does not reach adequate concentrations outside of the bladder, this would be a suboptimal therapy (7).

13- Priority is to select the narrow spectrum (7).

14- Other factors for consideration of specific antimicrobials include compliance, safety, and cost (24).

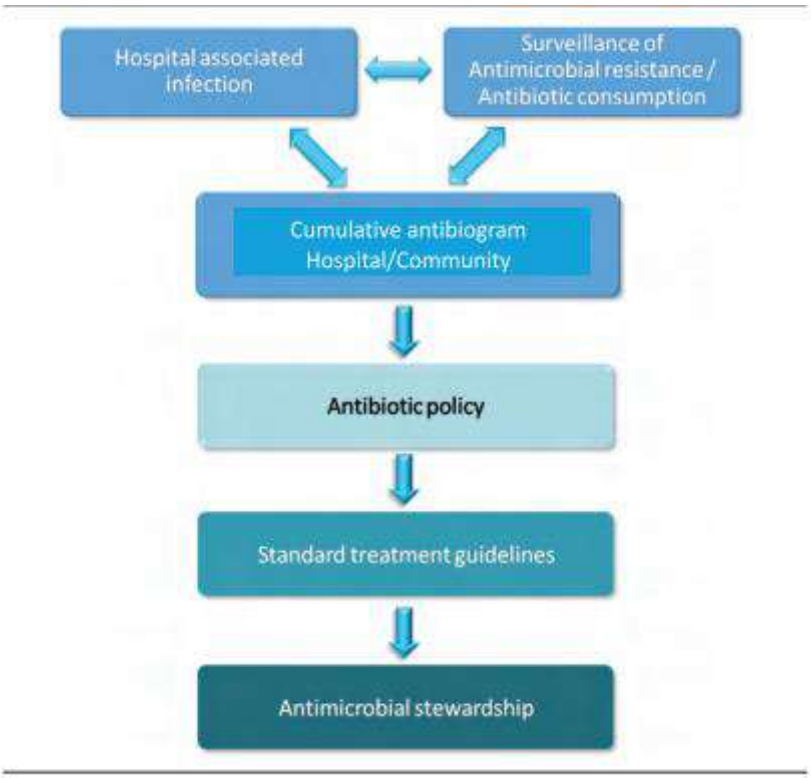

Figure 2. Process for the Development of Hospital Antibiotics Policy

Adopted from the World Health Organization. Step-by-step approach for the development and implementation of hospital antibiotic policy and standard treatment guidelines; 2021 [cited 2026 Feb 12]. Available from: https://iris.who.int/server/api/core/bitstreams/f2c9802e-649d-4313-9def-2e97db4ed831/content

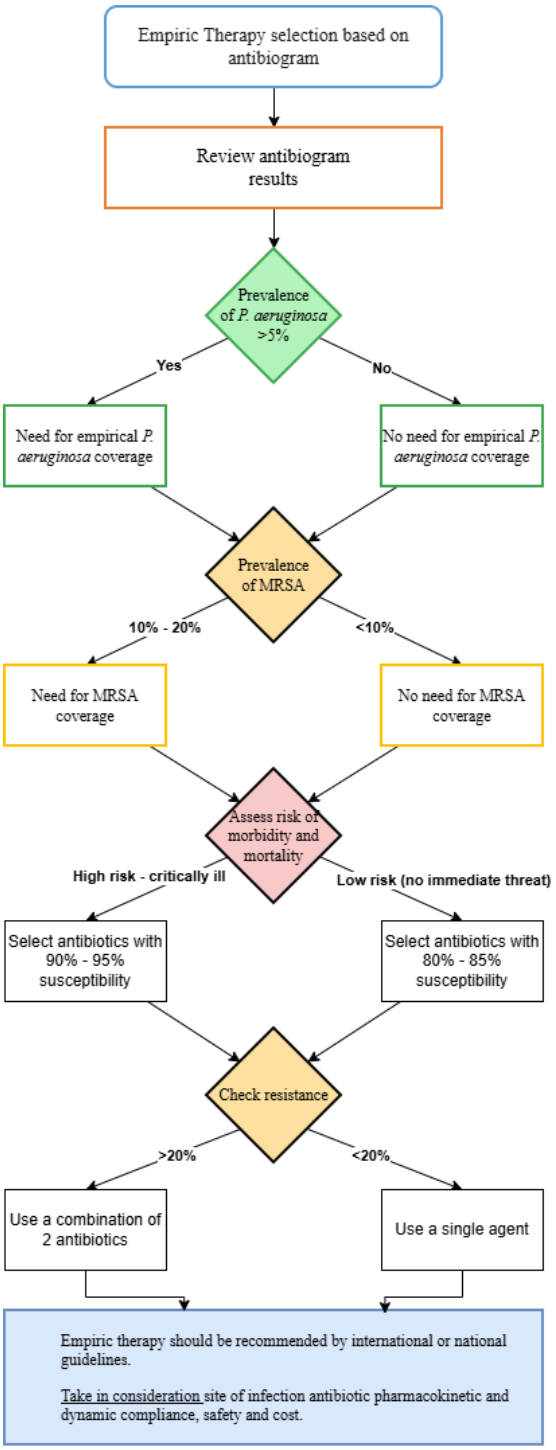

Figure 3. Selection of Empirical Therapy Based on Antibiograms

Key Considerations in Antimicrobial Prescribing

1- Antimicrobial should be selected for the specified indication that is consistent with antibiogram-guided local antimicrobial protocols, with the following considerations: (34)

- The required spectrum of activity
- Potential adverse effects
- Drug interactions
- Patient factors such as
- Recent antimicrobial use
- Allergy status
- Other diseases and conditions (such as renal impairment, pregnancy, and breastfeeding)

2- Appropriate dose, frequency, and route for the antimicrobial should be selected, considering the severity of infection, the site of infection, and any factors that may alter the patient's pharmacokinetics (34).

3- The duration of antimicrobial therapy should be prescribed in accordance with established clinical guidelines, with a clearly documented review or stop date (34).

Limitations of Antibiogram Applicability

Table 5. Limitations of Antibiogram Applicability.

Limitation	Handling
Lack of Time Relativity Antibiograms do not include the time of the sample collection relative to the hospital admission, making it challenging to differentiate between community-onset and hospital-onset infections (5).	Institutions may consider developing an antibiogram based on the timing of culture collection relative to patient admission. A standard definition of 48 h as the pivotal point can be utilized, in which <48 h is classified as community onset and ≥48 h as hospital onset. This stratification may offer a more accurate analysis of hospital versus community susceptibility rates and potentially lead to better representation of community versus hospital organism ecology, resulting in improved empiric therapy recommendations (7).
Culturing Practices Impact Antibiogram Data If only complicated or refractory cases are cultured (e.g., after empiric therapy), the antibiogram may overrepresent resistant organisms and include colonizers (16).	• Define and standardize culture collection practices (e.g., send cultures before empirical antibiotics whenever feasible) (16). • Exclude isolates likely representing colonization (e.g., surveillance swabs or repeat isolates within a specific timeframe) (16). • Document source of specimen (blood, urine, wound) and clinical context so antibiograms can be stratified or filtered by specimen type (16). • Use syndromic or source-specific antibiograms rather than single cumulative reports (16).

Not Helpful for Empiric Therapy in Recurrent or Recent Infection The antibiogram is not helpful for empiric therapy decisions for patients with recurrent or recent infections. Instead, users should use the patient's microbiology results and antimicrobial history to determine the best treatment (32).	• **Incorporate individual microbiology history into decision support systems**, so clinicians can see their patients' prior isolates and susceptibilities. • **Use escalation antibiograms** when infections don't respond to empiric therapy (32).
Missing Pharmacokinetic Factors Antibiograms do not include any pharmacokinetic factors such as site of infection, pharmacokinetic/pharmacodynamic parameters, contraindications, efficacy, safety, Clostridioides difficile risk, or other patient factors (33).	• Pair antibiograms with local or national treatment guidelines that account for PK/PD, contraindications, and special populations (e.g., renal impairment). • Consult pharmacists or infectious disease specialists for complex cases where pharmacologic factors are crucial (33).
Antibiograms Represent All Culture Sources Unless an antibiogram is a syndromic antibiogram, it includes data from all culture sources (blood, urine, etc.). This makes it more challenging to differentiate therapy for a specific type of infection. It also lacks information for managing infections with more than one pathogen (33).	• Create source-specific antibiograms (e.g., urine-specific, bloodstream infection, respiratory) to improve guidance for targeted syndromes. • Use syndromic antibiograms that weight organisms based on the infection type (e.g., pneumonia vs UTI). • Stratify antibiogram data by hospital unit or patient risk groups (e.g., ICU vs general wards) so that susceptibility patterns reflect clinical context (33).

Appendix: Example for interpretation and reporting key findings of the antibiogram

Antibiogram

Table 6. Antibiogram interpretation Example

Report Period: 1/1/2025-31/12/2025 **Total number of isolates for urine cultures: 250**					
Antibiotic Tested	**E. coli**	**Klebsiella pneumoniae**	**Proteus mirabilis**	**Methicillin Sensitive Staphylococcus Aureus(MSSA)**	**MRSA**
N of Isolates‡-%	100 (40%)	75(30%)	40(16%)	20 (8%)	15 (43% of Staph)
Ampicillin	10%	10%	30%	40%	0%
TZP	90%	80%	90%	58%	0%
Cefazolin	15%	0%	0%	70%	0%
Cefoxitin	20%	20%	15%	55%	10%
Ceftriaxone	0%	0%	0%	44%	0%
Nitrofurantoin	85%	88%	15%	30%	10%
TMP/SMX	15%	0%	0%	80%	85%
Levofloxacin	35%	40%	20%	48%	35%
Ciprofloxacin	30%	35%	12%	35%	30%
Clindamycin	10%	15%	10%	60%	80%

* Light blue bacteria are Gram-negative, and dark blue bacteria are gram-positive. Light yellow antibiotics are Oral, and dark yellow antibiotics are IV.

‡ These are pooled isolates by species Urine specimens.

Adopted from Agency for Healthcare Research and Quality (AHRQ). Toolkit 3 (13). https://www.ahrq.gov/sites/default/files/wysiwyg/nhguide/5_TK2_P2T8-Sample_Antibiogram_Phase_2.pdf

Report and Key Antibiogram Findings (from 1/1/2025 to 31/12/2025)

- Most of our data comes from urine cultures: Of 500 cultures used to make the antibiograms, 50% were urine cultures, 20% were wound cultures, and 30% were sputum cultures. The antibiograms will be most applicable when selecting antibiotics to treat urinary infections and systemic infections that may have come from the urine.
- The leading organisms for positive urine cultures were:
  - E. coli: 40% of urine cultures
  - Klebsiella pneumoniae: 30%
  - Proteus mirabilis: 16%
  - MSSA and MRSA are less than 30 isolates, so less statistical validity of the estimates of %S.
- Urinary tract infections (UTIs) from Gram-negative organisms
  - 86% of positive urine cultures were due to Gram-negative organisms.
  - Significant resistance to commonly used antibiotics is seen among the Gram-negative organisms that frequently cause UTIs (E. coli, Klebsiella):
  - TMP/SMX sensitivity for E. coli is limited (15%).
  - Quinolones' sensitivity for E. coli is limited (levofloxacin 35%, ciprofloxacin 30%).
  - First-generation cephalosporins' sensitivity for E. coli is limited: cefazolin, 15%.
  - Nitrofurantoin has good sensitivity for E. coli (85%), Klebsiella pneumoniae (88%) but poor activity against other urinary pathogens.
- Gram positives
  - 15 of 35 (43%) Staph. aureus cultures were MRSA.
  - MRSA was 85% sensitive to TMP/SMX and 80% sensitive to clindamycin.

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